JRC SCIENCE FOR POLICY REPORT

Impacts of the Cocoa Living Income Differential Policy in Ghana and Côte d'Ivoire

Boysen, O., Ferrari, E., Nechifor, N., Tillie, P.

2021

Contents

Abstract

Poverty continues to be a widespread issue among cocoa farmers while chocolate consumers become increasingly sensitive for the sustainability issues associated with the supply chain. The poverty issue is often attributed to the low prices of cocoa and the unequal distribution of profit margins across the chocolate value chain, at least partially. Poverty, in turn, is considered to be the root of further sustainability issues. To raise the value share and price accruing to their farmers by leveraging their collective market power, the two biggest cocoa producing countries Côte d'Ivoire and Ghana jointly announced in 2019 the cocoa Living Income Differential (LID) policy. The question is to what extent and under which circumstances could the policy reach this goal in the long run, considering the numerous unknowns around the details of the policy and market actors' reactions, and how sustainable it is. To analyse this question, we implement a global multi-regional partial equilibrium model of the world cocoa market to simulate scenarios accounting for alternative assumptions about these unknowns. The study shows that the LID's effects on prices and welfare of cocoa farmers in the two countries range from none to substantially positive, varying in magnitude with the scenarios. But it also highlights that the farmgate price target, which is reached in Ghana under most scenarios, is reached in Côte d'Ivoire only with additional supply management measures. The two countries' government budgets and cocoa farmers in other countries lose out substantially in many cases, what is identified, among other issues, as potential threats to the sustainability of the policy that require attention. Evaluated in light of past attempts by governments and other actors to raise farmer welfare in the cocoa but also other agricultural sectors, one policy alternative stands out, although coming with its own challenges.

Acknowledgements

Authors

Boysen, Ole	Joint Research Centre-Seville (Spain)
Ferrari, Emanuele	Joint Research Centre-Seville (Spain)
Nechifor, Victor	Joint Research Centre-Seville (Spain)
Tillie, Pascal	Joint Research Centre-Seville (Spain)

Executive summary

While the global chocolate market is highly valuable, only little of these profits is reaching the growers of cocoa beans. Cocoa farmers in Ghana and Cote d'Ivoire, the world's two largest cocoa producing countries, continue to be challenged by widespread poverty. In an effort to combat poverty among cocoa farmers and to increase the farmer's share in the value added of the global chocolate market by capitalizing on their combined market share of over 60% of global cocoa bean production, the governments of Ghana and Cote d'Ivoire jointly introduced the Living Income Differential (LID) policy to come into effect with the 2020/2021 harvest season.

The two countries agreed to charge an extra premium of USD 400 per tonne on all cocoa sales. The objective is to guarantee their farmers a fixed price of USD 1820 per tonne for the season which corresponds to a rise in the government institution-controlled annually fixed farmgate prices of roughly 20% to 30%. This LID premium is complemented by a price stabilisation fund intended to sustain the target farmgate price in case of slumps in the international cocoa price. Nevertheless, many details surrounding the implementation of the policy itself and potential accompanying measures as well as how the players in the cocoa markets will react to it in the long run remain unknown.

The present report adopts an economic model to quantitatively assess how alternative options for the implementation of the policy, accompanying supply control measures and behavioural reactions of the cocoa markets might affect international market prices, farmers' prices and welfare and government revenues as well as to explore potential challenges to the sustainability of the LID policy itself.

Policy context

This policy move is received with great attention by policy makers, civil society, and other stakeholders around the world, the more so because poverty is also considered to be a root cause for the major issues of child labour and deforestation associated with cocoa farming. It comes at a time when governments across the globe, including in the EU and the EU legislators themselves, are pressed by society to increase the accountability of internationally operating companies with respect to human rights and sustainability issues in their entire supply chains, especially regarding suppliers in developing countries.

Key conclusions

The results presented indicate the LID policy's effects to range from none to substantially positive for prices and welfare of cocoa farmers in Côte d'Ivoire and Ghana under all policy and market reaction configurations analysed. Government revenues from cocoa in the two countries could be substantially negatively affected. The magnitude of all effects varies greatly depending on a variety of factors linked to policy implementation details and market participants' behaviour. Moreover, the report underlines that implementation of complementary cocoa supply control measures is not only essential for creating the best outcomes for the cocoa farmers in the LID countries but it also is crucial for avoiding potentially strong, negative impacts on cocoa farmers in other countries.

The report furthermore identifies a number of challenges to the sustainability of the LID policy, varying with the policy's details and market participants' behaviour, which might need to be managed actively to prevent the failure of the policy with respect to improving cocoa farmers' welfare, the exacerbation of child labour and deforestation issues, disputes with other cocoa producing countries, and, finally, the break-up of the LID agreement between Côte d'Ivoire and Ghana itself.

1 Introduction

The global cocoa value chain is a link of extremes: On the one end, a global, 110 billion USD chocolate market (in 2013, Poelmans and Swinnen, 2016), dominated by a few big western manufacturing companies (Hütz-Adams and Schneeweiß, 2018), providing luxury indulgence to consumers predominantly in richer, western countries. On the other end, five to six million (WCF, 2012) predominantly and often extremely poor smallholder cocoa farmers (FAO and BASIC, 2020) growing the principal ingredient, largely located in a few, poorer tropical countries. Part of the explanation might be found in the distribution of the revenue generated along the chain. According to estimates by Fountain and Hütz-Adams (2015), final manufacturers and retailers obtain a share of 79.4% of the final chocolate product's sales price whereas cocoa farmers obtain 6.6% as estimated by Fountain and Hütz-Adams (2015) or 11% as estimated by FAO and BASIC (2020). However, to what extent this unequal distribution is the result of market power issues in the supply chain is disputed, see discussions in Bonjean and Brun (2016), Gayi and Tsowou (2016), Gilbert (2008) and Hütz-Adams et al. (2016).

Côte d'Ivoire and Ghana are the two biggest cocoa producers, accounting for 45% and 17.2% of global cocoa bean production, respectively, in 2019 (ICCO, 2020b). Most of the cocoa is exported, largely as beans or first stage processed products, generating 38.9% of Côte d'Ivoire's and 16.2% of Ghana's total merchandise export earnings in 2019 (UN comtrade, 2021). This exemplifies the great importance of cocoa for these economies.

Nevertheless, widespread poverty among cocoa farmers has been a long-standing challenge in the two countries. 54.9% and 26.9% of cocoa farmers are living below the national poverty line in Côte d'Ivoire in 2014/2015 (World Bank, 2019) and Ghana in 2012/2013 (Vigneri and Kolavalli, 2018), respectively, meaning that they have insufficient income to meet their most basic food and non-food needs. Cocoa farming households in Côte d'Ivoire and Ghana typically depend strongly on the income from cocoa sales, which accounts on average for 66% and 61% of total household income, respectively (Bymolt, Laven and Tyszler, 2018). Correspondingly, these households' incomes are strongly influenced by the price they receive for cocoa at the farmgate. Poverty, in turn, is regarded as a root cause for two other major issues of sustainability associated with cocoa farming, the high prevalence of child labour in the cocoa sector and continued clearance of protected tropical forest areas (Fountain and Hütz-Adams, 2020).

Lacking the means for mechanizing farm work or hiring sufficient adult labour, poor cocoa farmers often have no choice than to resort to child labour for survival (Sadhu et al., 2020). However, sacrificing children's formal education also decreases their capacity for becoming economically independent and escaping poverty in the future (Luckstead, Tsiboe and Nalley, 2019). The 2018/2019 survey data analysed by Sadhu et al. (2020) indicates that of the children from agricultural households in cocoa farming areas aged between five and 17, 45% are engaged in child labour in cocoa production (790,000 children in Côte d'Ivoire and 770,000 in Ghana). Around 95% of these children also carry out tasks categorized as hazardous child labour, such as dangerous or heavy tasks or working long hours or at night.

In addition, poor farmers cannot afford more advanced farming practices that use fertilizers and pesticides, which again is a reason for the low productivity of their cocoa trees and thus their low incomes (Kongor et al., 2018). Cocoa farming causes deforestation in a perpetual process: Cocoa trees need four years to become productive and their yields start declining after 18 years (Binam, Gockowski and Nkamleu, 2008). According to Amanor, Yaro and Teye (2020), old cocoa plantations become susceptible to diseases and pests and suffer from low soil fertility. The remedy against declining yields would be replanting and application of fertilizers and pesticides. However, the cost of replanting in terms of labour, fertilizer and pesticides is much higher than clearing and planting in newly cleared forest area (Kolavalli and Vigneri, 2011), which provides fertile soils for good yields. Moreover, by expanding to new land, farmers retain the income from the old trees while the new trees mature (Bymolt, Laven and Tyszler, 2018). Under these conditions, maintaining the income level requires perpetual conversion of forests.

Goldman et al. (2020) estimate that over the 2001–2015 period, cocoa farming has caused 1.9% of global agriculture-linked deforestation. Even though a smaller share compared to that attributed to each of cattle, oil palm, and soy, it particularly affects rainforests in biodiversity hotspot areas (Kroeger et al., 2017). According to WRI (2021), Côte d'Ivoire and Ghana accounted for 22% and 10% of the total cocoa-related deforested area, respectively. This corresponds to 25% and 33% of total tree cover loss in Côte d'Ivoire and Ghana over that period, respectively.

As consumers, civil society, and governments increasingly become sensitive to the human rights and sustainability issues in the chocolate supply chain (Barrientos, 2016; Fold and Neilson, 2016), the pressure on chocolate traders and manufacturers mounts to eradicate the causative practices, including the issue of cocoa farmers' low incomes. Moreover, under the seventh International Cocoa Agreement from 2010, a number of

cocoa producing and consuming member countries of the International Cocoa Organisation (ICCO), which also include Côte d'Ivoire, Ghana and the European Union, have committed to improve the livelihoods of cocoa farmers and the environmental sustainability of the cocoa supply chain (UNCTAD, 2010).

1.1 The price determination process

The cocoa markets in Ghana and Côte d'Ivoire are both strongly regulated and their market programs include measures to improve the livelihoods of the cocoa farmers, affecting productivity, quality and farmgate prices (Grumiller et al., 2018). With respect to farmgate prices, both countries adopt stabilization funds and seasonal price fixing mechanisms which largely guarantee a minimum price to the farmers throughout the season (Grumiller et al., 2018), thereby reducing intra-seasonal price variability (Tröster et al., 2019) and bargaining power of intermediaries in the supply chain from the farmgate to exporters. Quality management measures in both countries have led to higher quality beans which achieve a premium on world market prices (Tröster et al., 2019). In both countries farmers only receive a share of the international market price, after deductions of taxes and other sector-specific levies, which in part are used to provide inputs and public services to the cocoa farmers (Tröster et al., 2019).

In Ghana, the state-owned Ghana Cocoa Marketing Board (COCOBOD) directly or indirectly controls all purchases, sales and exports of cocoa but provides a range of services including quality control and transportation. COCOBOD sets cocoa farmgate prices once per year in a multi-stakeholder approach around the start of the harvesting season in October. The fixed price has to be paid by all buyers of cocoa beans to the farmers, without room for negotiation, thereby shielding farmers from bargaining power issues.

As described by Kolavalli and Vigneri (2017), the price determination process begins after 60% to 70% of the predicted main harvest has been forward sold. First, the expected cocoa revenue is calculated from predictions for the year of the gross FOB export price in USD, the Cedi to USD exchange rate, and the harvest. Then, some amount is deducted to cover the cost of a number of services, such as cocoa research, jute sacks, disease and pest control, scholarship funds, actions to reduce child labour, and certification, and the net FOB price per tonne is calculated. Finally, the net FOB price is divided between all agents involved in cocoa production and marketing, including COCOBOD and the government, where the farmers' share typically amounted to around 60% to 70% in recent years.

Thus, measured against the gross FOB price, in recent years cocoa farmers frequently received a share of below 70%, see Bymolt, Laven and Tyszler (2018) and Oomes et al. (2016). While Ghana does not explicitly levy taxes on cocoa beans exports, the producer price fixing mechanism causes a high implicit taxation of all cocoa bean sales which also includes the selling to domestic processing companies (WTO, 2014). On the other side, the mechanism provides a degree of price stability to the farmers while allowing for some transmission of international market price changes (Quarmine et al., 2014).

In Côte d'Ivoire, the cocoa board Conseil du Café-Cacao (CCC) is responsible for the sector's regulation including setting of guaranteed minimum farmgate prices, price stabilisation and allocation of export licenses (Bymolt, Laven and Tyszler, 2018). The cocoa bean price for the next season is fixed after 70% to 80% of the upcoming year's harvest has been forward sold in auctions and, in the past years, a minimum of 60% of the Cost-Insurance-Freight (CIF) price was guaranteed as the farmgate price (Oomes et al., 2016).

Côte d'Ivoire levies an export tax of 14.6% and a registration fee of 0.94% on raw cocoa beans and for processed cocoa products this tax rate decreases with increasing level of processing (WTO, 2017), thereby encouraging domestic processing. The cocoa farmers typically received well below 70% of the international market price over the past years (Oomes et al., 2016).

1.2 The Living Income Differential

While over the past decades governments, civil society, and chocolate traders and manufacturers have implemented a variety of programs which include measures to improve cocoa farmers' livelihoods, as summarised in Section 2, these have disappointed to bring substantial improvement for cocoa farmers, as illustrated by the persistence of poverty among them.

In 2019, Côte d'Ivoire and Ghana jointly announced the Living Income Differential (LID) policy (FCC, 2019), which is a new attempt to capitalize on their collective market power to raise the farmgate price and thereby the share their farmers receive from the value of the global chocolate market, bringing them closer to an income that allows a decent standard of living. The LID itself is a USD 400 per tonne markup on top of the Free-on-Board (FOB) price of cocoa beans which is applied to all cocoa sales starting with the harvest season 2020/2021.

In order to provide a more stable farmgate price, the LID is complemented by price stabilization funds (FCC, 2019). The basis is a floor export price of USD 2600 per tonne including the USD 400 of the LID, of which farmers shall receive 70%. Correspondingly, farmers would be guaranteed to receive a price of at least USD 1820 per tonne. This amounts to a roughly 20% to 30% rise in the government institution-controlled annually fixed farmgate prices for 2020/2021 compared to the 2019/2020 season (Fountain and Hütz-Adams, 2020). According to FCC (2019), the price stabilisation fund pays the shortfall when the export price including the LID falls below USD 2600. When it exceeds USD 2900, the excess is held back and transferred into the stabilisation fund.

1.3 Unknowns around the LID

While the sales of cocoa beans under the new policy have progressed, no official documents detailing the LID and flanking policies have been published. Several unknowns around the details of the policy's implementation remain:

— Is the LID markup subject to the same levies as the export price itself or is it paid to the farmers in full?

— Are the levies from the export price, i.e., the gap between the FOB export price and the farmgate price, reduced from present levels down to 30%?

— Are the governments ready to defend the floor price, even if this exceeds the stabilisation fund?

— Is the expansion of cocoa production limited through supply control measures and if so, by which ones?

— Are the governments supporting private or public stockholding to influence the global market price and to what extend?

In addition, success and costs of the LID policy with respect to the objectives of the target farmgate price and farmers' incomes depend on how the market actors – particularly chocolate manufacturers, and cocoa farmers and governments elsewhere – in the rather concentrated global cocoa market will react to it in the long run.

Buying cocoa beans from Ghana and Côte d'Ivoire and paying the LID might provide chocolate manufacturers with benefits in form of an improved corporate image, conveying the image of responsible and sustainable chocolate production. In fact, the fear of negative impacts on company reputation with consumers has been a strong driver for engaging with sustainability issues in the supply chain (Thorlakson, 2018). On the other hand, higher beans input costs might shrink profits or require higher sales prices which could decrease sales. Correspondingly, in evaluating the outcomes of the LID, it needs to be considered to what extent chocolate manufacturers might adapt their sourcing of beans in response to the new prices and to what extent they might pass higher cost of beans on to the consumers.

While several large chocolate traders and manufacturers have expressed their support for the LID initiative and cocoa beans sales have progressed at prices including the LID (Aboa and Angel, 2019b, 2019a), there also were reports or suspicions that some companies might have been increasing their purchases from non-LID countries or the commodity exchange to avoid the LID (Aboa, 2020; Almeida, Mieu and Bassompierre, 2020).

Regarding the LID's impacts on consumer prices, calculations for France by FAO and BASIC (2020) indicate that, in 2018, on average 90% of the margins generated over the cocoa supply chain accrue to the final chocolate manufacturers and retailers so that there might be scope for redistributing some amount down to the farmers without the need for raising consumer prices. They calculate for the examples of plain milk and dark chocolate bars in France margins in the value chain downstream from the cocoa farmers of 149% and 180%, respectively, compared to the part of the bar's total costs going to the farmers. For the case that companies pass the cost for the LID on to consumers, the authors simulate the same value chains and estimate an increase in the consumer prices of the chocolate bars by 1.5% and 2%, respectively.

While it is clear that an increase in farmgate prices stimulates cocoa farmers to expand production, it is less clear how large their supply response might be, in particular, in view of the combined market share of the two countries and accounting for the feedback from the world market price and what that means for the goals of increasing farmgate prices and farmer incomes or what additional measures would be necessary to reach those goals. Moreover, the extent to which these goals are reached varies with the unknowns around the details of the LID and accompanying policies as well as with the market actors' behavioural reactions. The final question mark is behind the sustainability of the LID policy itself, e.g., as it might have substantial effects on the government budgets of Côte d'Ivoire and Ghana, for which revenues from cocoa are an important source, and its effects on the sustainability of the cocoa sector as discussed above.

To shed light on the potential outcomes following the introduction of the LID, the present study conducts a series of thought experiments on how the policy might play out under varying assumptions about the above unknowns, especially with respect to the important issues of cocoa bean prices, farmers' welfare, and government revenue in Côte d'Ivoire and Ghana but also considers the implications for other cocoa producing countries. Thus, the experiments revolve around two main questions. What could be the impacts of the LID policy itself? And what could be the impacts of the LID if the two governments were strictly committed to reach the target farmgate price of USD 1820? Furthermore, a number of threats to the sustainability of the LID policy and the sustainability of the cocoa sector are identified by evaluating the results in light of past attempts to raise farmer welfare in the cocoa and other agricultural sectors by governments and other actors. To the best of our knowledge, this study presents the first attempt to model and quantify the long-run impacts of the LID policy.

The remainder of the report is organized as follows. Section 2 provides an overview of other past and present attempts to improve cocoa farmer livelihoods. Section 3 describes the model, data and simulation scenarios before Section 4 evaluates the simulation results and Section 5 enters a wider discussion. Section 1 presents conclusions and policy recommendations.

2 A brief overview of past and present initiatives to improve the livelihoods of cocoa farmers

Over time, governments, civil society, and companies from the chocolate supply chain have implemented a variety of programs which included measures to improve and stabilize cocoa farmers' incomes by targeting cocoa prices, quality, productivity, or input costs.

Between 1972 and 1988, an international buffer stock scheme to stabilize international cocoa prices at a "remunerative" level was operated under the International Cocoa Agreement (ICCA) supported by 30 countries (Gilbert, 1996; Gibson, 2007). However, the authority established to run the buffer stock got never equipped with sufficient funds for effective market interventions, with member countries pushing for support of too high price bands thereby causing stock capacities to fill up quickly during a period of low prices (Gibson, 2007). This effectively disabled the scheme and ultimately led to its suspension (Gilbert, 1996).

Beginning from the late 2000s, the emphasis for raising cocoa farmers' incomes has been on sustainability certification schemes run by civil society organisations, such as Fairtrade or Rainforest Alliance (Fountain and Hütz-Adams, 2018; Thorlakson, 2018). Revelations of poverty, child and slave labour and deforestation associated with cocoa farming have created demand from consumers who wish to buy responsibly and are ready to pay a premium for chocolate certified for avoiding these issues (Voora, Bermúdez and Larrea, 2019). Certification can impact farmers' incomes directly via negotiated or fixed price premiums and minimum prices or indirectly via agricultural training associated with the certification and the strengthening of farmer organisations, e.g. through advisory services and premium payments (Hütz-Adams and Schneeweiß, 2018). The latter might improve productivity and quality.

According to Hütz-Adams and Schneeweiß (2018), all certification schemes include measures aiming at the increase of productivity. The premiums paid go partially to the farmer's cooperative and partially directly to farmers. However, the average premium achieved by a farmer for all beans grown under certification is usually rather low because, due to a lack of demand, only a fraction of the beans is sold as certified and subject to premium payments while the rest, between 20% and 60% according to Fountain and Hütz-Adams (2018), is sold as conventional. Currently, Fairtrade is the only standard that pays fixed price premiums and a minimum price (Fountain and Hütz-Adams, 2018), which is important in view of the weak bargain power of farmers.

The impact of organic certification on the farmgate price is markedly greater. FAO and BASIC (2020) model the value share distribution along the value chain for French premium dark chocolate bars and find, for example, that farmers' in 2018 could achieve an 18.3% higher revenue with a Rainforest Alliance than without any certification but combining Fairtrade and organic certifications, they could achieve a 114.3% higher revenue. In any case, due to a lack of data on the costs of production for certified and non-certified cocoa, the effects of certification on net farm income remain unclear (Hütz-Adams and Schneeweiß, 2018).

In addition, certification reaches mainly the large farmers or those who are organized in a cooperative as these can be certified cost-efficiently while other farmers remain excluded (KPMG, 2013; Hütz-Adams et al., 2016). Meier et al. (2020) estimate that between 32.5% and 51.8% of global cocoa production in 2018 were certified with sustainability standard and 3.4% with organic labels. Exact estimates are difficult due to double and triple certification (Hütz-Adams and Schneeweiß, 2018). Fountain and Hütz-Adams (2018) assess that, while certification might increase cocoa farmers' incomes slightly, the average certified cocoa farmer remains poor.

Over more recent years, chocolate manufacturers have started to move towards in-house, own-supply chain sustainability programs, either replacing or supplementing the independent certification schemes (Thorlakson, 2018; Krauss and Barrientos, 2021). Many large chocolate traders and manufacturers have set goals for achieving 100% sustainable sourcing before 2030 (Voora, Bermúdez and Larrea, 2019). Companies usually do not define "sustainable cocoa" but the programs are centred on productivity and child labour issues and increasingly also include gender and deforestation but not prices (Thorlakson, 2018). Interestingly, companies do not regard consumer demand as a major driver for certified chocolate which is attributed to the presence of an attitude-behaviour gap (Thorlakson, 2018). Instead, the companies seem motivated by the desire to limit the risk of decreasing cocoa supplies and future shortages (Fold and Neilson, 2016; Oomes et al., 2016; Odijie, 2018; Krauss and Barrientos, 2021) and the risk of reputation damage from non-sustainable behaviour causing penalization by consumers (Thorlakson, 2018). The latter follows from the realization that certification does not prevent consumers from accusing a chocolate manufacturer for issues like child labour or deforestation occurring in its supply chain (Thorlakson, 2018).

Larger chocolate traders and manufacturers might implicitly pay premiums through the third-party certification scheme they use as part of their in-house programs, but no additional premiums are paid (Maile, 2020). Only

some small manufacturers are paying prices above international market prices using fixed premiums, minimum prices or even a fixed living income price, see Aidenvironment (2018) and Hütz-Adams and Schneeweiß (2018).

Recently, also multi-stakeholder initiatives in chocolate consumer countries with government participation (e.g., German Initiative on Sustainable Cocoa, Swiss Platform for Sustainable Cocoa, or the Belgian platform Beyond Chocolate) have started to press domestic chocolate suppliers for more transparency and accountability towards sustainability in their supply chains, including a living income for farmers. In 2020, the European Union (EU) launched the EU Multi-Stakeholder Dialogue for Sustainable Cocoa with a focus on Côte d'Ivoire and Ghana to foster discussion and coordination among all stakeholders (EC, 2020). The dialogue is also intended to inform the European Commission's ongoing legislation effort towards mandatory due diligence for EU companies within their supply chains regarding human rights and sustainability issues.

3   Methods

The experiments are based on a comparative-static analysis taking a long-run view of the market for cocoa beans. It does not try to predict the changes emerging in, for example, one or three years but instead investigates to what long-run equilibrium the market of 2019 would settle after the introduction of the LID if everything else remained unchanged. That means population, preferences, production technology, weather, policies in other countries, and so on, all remain as in 2019 and all market participants have enough time to fully adapt to the new situation. Thus, the analysis asks the question what if the LID had existed already in 2019 and facilitates a comparison to the 2019 reality without the LID.

Given the dominant share of cocoa produced by Ghana and Côte d'Ivoire, the LID policy will substantially affect the global cocoa market and result in feedback effects through export prices. To account for these effects, a global cocoa market model representing the rest of the world besides Ghana and Côte d'Ivoire has been developed.

3.1   The global cocoa bean partial equilibrium model

The global cocoa model developed is a single product, multi-region, partial equilibrium (PE) model covering the global economy for cocoa beans. Each region is represented by a set of iso-elastic supply and demand functions. These functions depend on the respective cocoa bean price that is reflecting the incentives relevant for producers or consumers, i.e., it accounts, e.g., for taxes and subsidies. All national markets are linked via the international market which requires that exports and imports balance globally.

Cocoa beans are treated as being homogeneous. However, export prices vary between producer countries due to transaction costs but also due to quality differences, such as national quality standards, fine cocoa or cocoa certified for sustainability or ethical trade. The corresponding price differential is introduced as a multiplication factor on the international price to arrive at the domestic price. Thus, all regions' domestic prices differ from the international price. The latter is calibrated to equal the annual average international price as published by ICCO. Cocoa trade is represented non-spatially as net exports. To some extent, averaging across types of cocoa conforms with reality, where cocoa certified for sustainability, thus more expensive cocoa beans but with otherwise identical properties, often are physically mixed with non-certified ordinary ones ('mass balance approach', Stoop *et al.*, 2021). This model simplification, which also averages, e.g., across fine or special-origin cocoa, is necessary as data that differentiates types of cocoa is not sufficiently available.

3.2   Data

The base data for the PE model has been compiled from the Quarterly Bulletin of Cocoa Statistics (ICCO, 2020b). This includes cocoa bean data on international prices and quantities of national production, exports and imports and changes in stocks. Demand is proxied by bean grindings. For this study, all data is aggregated to the three regions Côte d'Ivoire, Ghana and Rest of the World (ROW). According to the data, in 2019, Côte d'Ivoire, Ghana and ROW accounted for 45%, 17% and 38% of global cocoa bean output and the same shares of exports while ROW accounted for virtually all imports. Data on national farmgate prices for 2006–2017 are taken from ICCO (2020a) and amended with individual data points for 2018 and 2019 for Ghana and Côte d'Ivoire from press announcements.

Because of the price fixing processes in Ghana and Côte d'Ivoire which are not completely transparent, levies from the international cocoa price to arrive at the national farmgate prices have been estimated from the above 2006 to 2019 national farmgate price data by a simple regression for each region separately. As the producer prices in Ghana and Côte d'Ivoire are fixed once per year based on the average price achieved through forward sales of the upcoming cocoa harvest but the physical export largely occurs later, the link between their current year's farmgate prices and last year's international price is stronger than with the current year's price. Thus, in the regressions for these regions, the international price is included with a one-year lag. The estimates of these levies applied to the FOB export price (henceforth called "FOB price levies") amount to 44.2%, 45.1%, and 18.6% for Ghana, Côte d'Ivoire and ROW, respectively. In the global cocoa model, they are applied as producer taxes and thus affect export as well as domestic sales of the beans.

Estimates for the long-run price elasticities of cocoa demand and supply are taken from the literature. A search for estimations published since 2000 yielded studies by Burger (2008), Gilbert and Varangis (2004), Gilbert (2012), Gilbert (2014), ICCO (2008), and Tothmihaly (2018). Therein, the price elasticities of world cocoa demand estimated range from -0.19 to -0.96. For the price elasticity of cocoa supply, estimates range from 0.285 to 0.57 for world supply, from 0.43 to 0.58 for Côte d'Ivoire, and from 0.43 to 0.64 for Ghana. Here, the

most recent estimations in the literature by Tothmihaly (2018) are adopted, who estimated long-run price elasticities of world supply of 0.57 and of demand of -0.34, respectively. These seem plausible considering the range of other estimates found. In general, the supply and demand elasticities are expected to be low (highly inelastic) because cocoa trees are a long-run investment and cocoa beans amount to only a small share of the final price of chocolate products, a product group with no close substitutes. The same elasticities are used for all countries.

Acknowledging the uncertainty around the estimates and to check the sensitivity of the results with respect to these, all simulations are repeated with alternative price elasticities, selected from the other end of the range the authors deemed plausible, the demand elasticity of -0.19 from Gilbert and Varangis (2004) and the supply elasticity of 0.285 from Gilbert (2016). The price elasticities of demand and supply are combined into three alternative sets as follows: Set A: -0.19 and 0.57, set B: -0.34 and 0.285, and set C: -0.19 and 0.285.

3.3 Scenarios

The year 2019 is taken as the reference point for the analysis. In 2019, the annual international cocoa bean price as published by ICCO was relatively low at USD 2268 per tonne. After two peaks in 2010 and 2016, the real price, deflated to 2019 USD prices using the Manufactures Unit Value (MUV) index, dropped strongly in 2017, see Figure 1, and has only recovered fractionally since (as of May 2021).
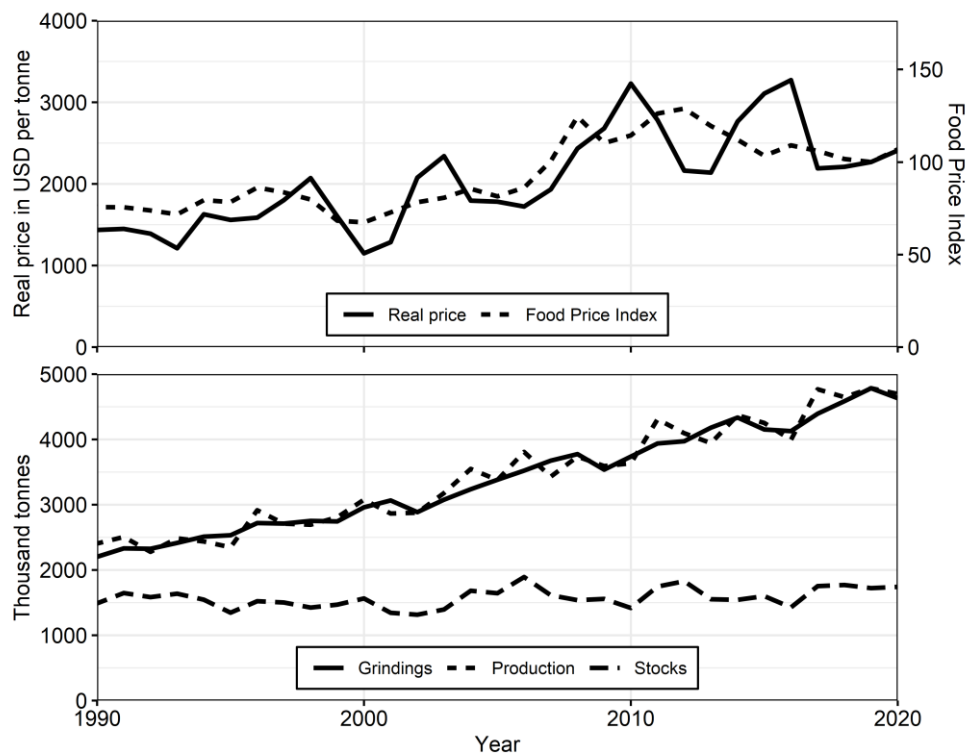

Figure 1. Historic international cocoa bean prices and the general Food Price Index (FPI, base=2019) and global production, grindings and stocks. The years for all data apart from the FPI refer to the harvest season from October of the previous year to September in the year shown. Real prices are shown in constant 2019 USD, deflated using the MUV index. Source: Prices, production, grindings, and stocks from ICCO (2020b); MUV and FPI from World Bank (2021).

The simulation scenarios examine the impacts of the LID policy change while varying the assumptions on the unknowns around the LID. All scenarios assume that Ghana and Côte d'Ivoire introduce all policies in a synchronized manner.

The first set of scenarios (the LID scenarios) examines the introduction of the LID of USD 400 per tonne and the reduction of the export price levy to 30%. The assumptions of the main *LID* scenario, which is used as a basis for the other scenarios, follows the details from the FCC (2019) document as well as reports from the press. The resulting *LID* scenario takes a rather optimistic view from the perspective of the first-order impact on farmgate prices in Côte d'Ivoire and Ghana. It assumes that the chocolate manufacturers are paying the LID without letting it influence their sourcing decisions, the FOB price levies in Ghana and Côte d'Ivoire are reduced

to 30% and also extend to the LID amount, and chocolate manufacturers are not passing on the additional cost to the final consumers.

If the chocolate manufacturers instead would let the LID influence their sourcing decisions, the LID markup would act like an output tax and hence as a disincentive to production for domestic cocoa producers. However, as this markup would eventually be paid back to the producers, the tax effect is cancelled out completely and, on balance, the LID would have no effect at all. This situation is what is referred to below as the competitive market assumption. Nevertheless, the reduction of the FOB price levy would still create effect a production incentive.[1] Such cases are only analysed within the second scenario set.

The subsequent scenarios are all modifications of the main *LID* scenario and only the modifications are described. In the *LID full* scenario, the LID markup is paid to the farmers without levies. The consumer price (*Cons.price*) scenario implies that chocolate manufacturers do pass on the higher beans cost to the consumers, thereby causing a demand reaction. The levy from the FOB price in the *Pre-LID levy* scenario remains at above 40% in the two countries, as before the introduction of the LID. Finally, the *Quota* scenario assumes that Ghana and Côte d'Ivoire are committed to limit the cocoa production to the pre-LID level, for example, by applying a production quota. Here and in following scenarios involving a quota, it is assumed that quotas are administered such that the quota rent accrues to the cocoa farmers.

The second scenario set "target price at farmgate" (TPFG) investigates the impacts if the two governments are strictly committed to reach the target farmgate price. That is, it investigates what magnitude of measures it takes to drive the international market price up so that the price at the farmgate reaches the target of USD 1820 per tonne by using either supply limits (*TPFG quota*) or governmental stocks (*TPFG stocks*). The *Competitive Market (CM) TPFG quota* and *CM TPFG stocks* scenarios are identical to the previous two but assume that the chocolate manufacturers are not willing to ignore the LID markup in their sourcing decisions, thus rendering the LID ineffective.

To reach at minimum the target farmgate price, both countries limit their supply to or buy up into the stock the same share of beans relative to their pre-LID supply. This latter assumption is important as Côte d'Ivoire's production is much higher and its farmgate price initially is further below the target compared to Ghana's. Without it, Ghana could free ride and let Côte d'Ivoire bear the entire burden of market supply reduction required to move the world market sufficiently. The scenarios are summarized in Table 1.

Table 1. Scenario overview

Scenario	Description
LID	LID altruistically paid; farmers receive 70% of gross FOB export price incl. LID; higher beans cost not passed to final consumers
LID full	Same as LID but farmers receive full LID of USD 400
Cons.price	Same as LID but higher beans cost passed on to final consumers
Pre-LID levy	Same as LID but FOB price levy is equal to its higher pre-LID level
Quota	Same as LID but Ghana and Côte d'Ivoire limit production to pre-LID level
TPFG quota	Same as LID but Ghana and Côte d'Ivoire decrease production by same share to reach USD 1820 target farmgate price
CM TPFG quota	Same as TPFG quota but no altruistic payments, thus LID ineffective
TPFG stocks	Same as LID but Ghana and Côte d'Ivoire buy up same share of national production to reach USD 1820 target farmgate price
CM TPFG stocks	Same as TPFG stocks but no altruistic payments, thus LID ineffective

---

[1] Likewise, if the LID markup is paid in full to the farmers, the tax on the markup would be gained by farmers and create an incentive.

4 Results

The results from the PE model simulations of the LID policy scenario set are discussed in Section 4.1. Section 4.2 shifts the discussion to the TPFG set of scenarios which assesses the magnitude of policies necessary and their impacts if the target farmgate price is required to be reached. To results from the sensitivity analysis are contrasted with those obtained using alternative elasticity sets in Section 4.3.

4.1 The LID scenarios set

In the 2019 base data, farmers in Côte d'Ivoire and Ghana receive producer prices of USD 1290 and 1501 per tonne, respectively. In the main *LID* scenario, there are two separate changes which increase the farmgate prices. One is the LID markup to the FOB price of USD 400 per tonne. The other is the decrease of the FOB price levies from 45.1% in Côte d'Ivoire and 44.2% in Ghana to 30%. Ignoring market reactions, this would mean a rise in farmgate prices in Côte d'Ivoire and Ghana to USD 1925 and USD 2162 or by 49.2% and 44%, respectively.

These initial price shocks incentivize farmers in Côte d'Ivoire and Ghana to expand production, which, given their combined global cocoa market share of 62%, has a substantial impact on the international market. In the emerging equilibrium, the international price drops by 15.6% resulting in output rises in Côte d'Ivoire and Ghana of 15.9% and 13.3%, respectively, while cocoa production in other countries falls by 9.2% (Figure 2). On balance, global supply increases by 5.9%, see Figure 3.
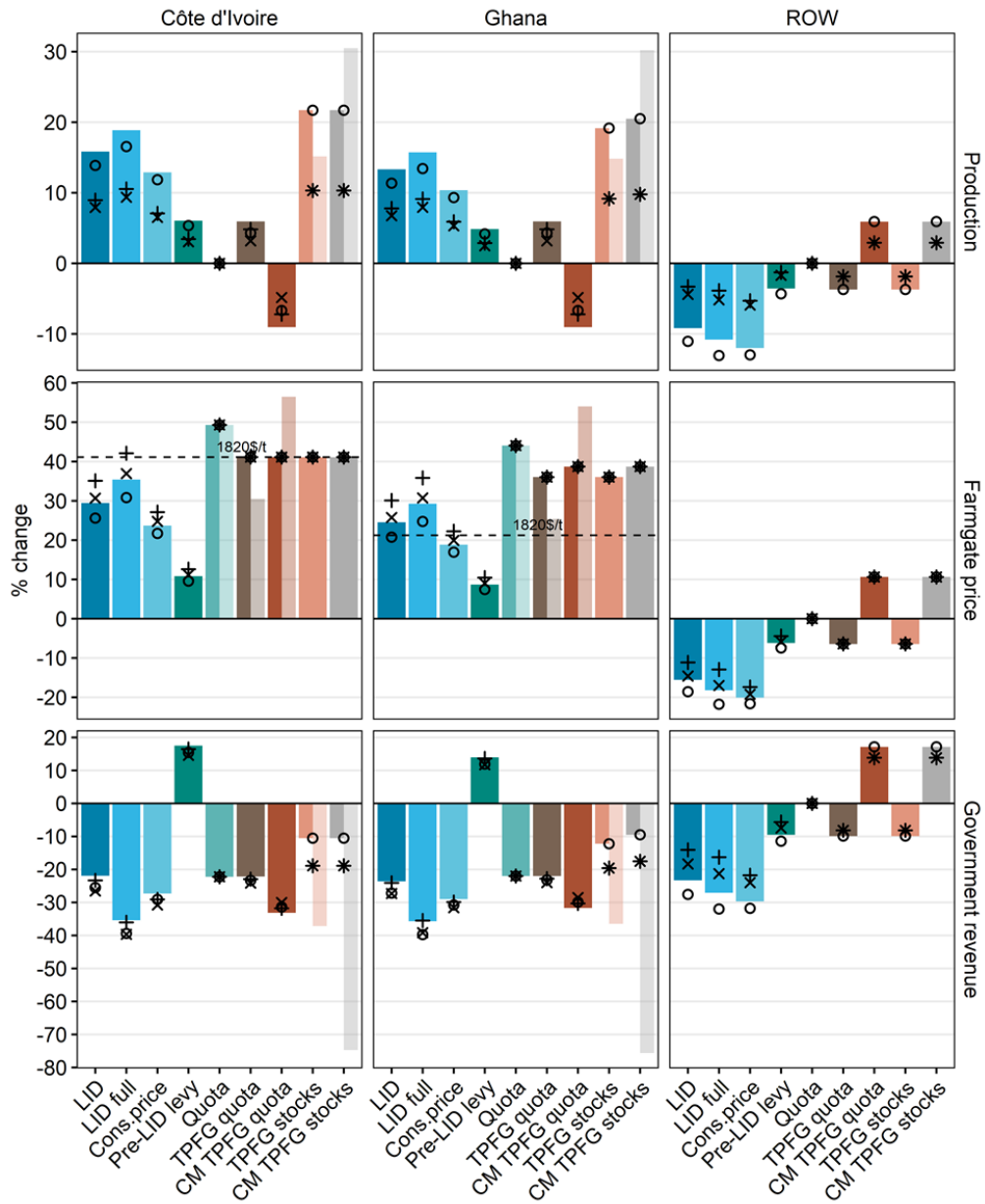
Figure 2. Change in cocoa bean production, farmgate prices, and government revenue from pre-LID levels by region. Production: Light-coloured slim bars represent production bought into stocks as share of pre-LID production. Farmgate price: Dashed horizontal lines indicate the percentage increase required to reach the USD 1820 per tonne target farmgate price. Light-coloured slim bars represent the magnitude of the quota as a share of the pre-LID farmgate price. Government revenue: Light-coloured slim bars represent the cost of stock outlays as a negative percentage of pre-LID government revenue. ○, +, and × indicate results from alternative elasticity parameter sets A, B, and C, respectively.
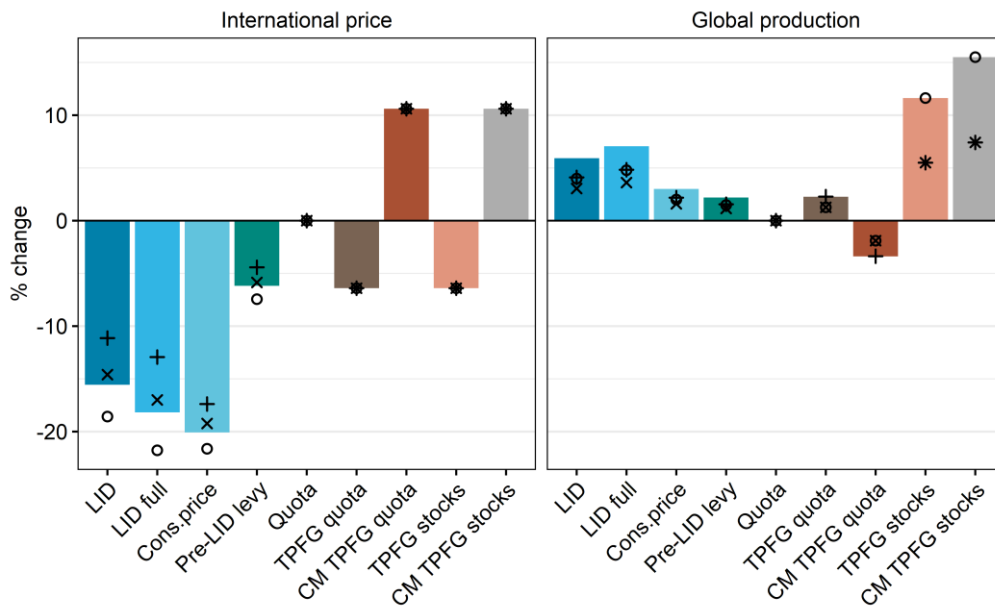
Figure 3. Change in international price and global production from pre-LID levels. ○, +, and × indicate results from alternative elasticity parameter sets A, B, and C, respectively.

The farmgate price – the stated objective of the LID policy – rises to USD 1669 (+29.5%) in Côte d'Ivoire and USD 1870 (+24.5%) in Ghana, see Figure 2. Thus, the target of USD 1820 is reached in Ghana but not in Côte d'Ivoire. The price for farmers elsewhere drops by 15.6%.

The revenue from levies on the cocoa export price, henceforth for the sake of brevity called government revenue, decreases in the LID countries by slightly above 20% (Figure 2) as the increase in the FOB (including LID) price and the increase in sales is not sufficient to offset the cut in the rate of the levy to 30%. The revenue for ROW governments decreases due to lower sales and lower prices by over 23.3%.

With production and prices increasing, cocoa producer welfare in the LID countries, measured in terms of producer surplus, increases substantially (Figure 4). By contrast, for cocoa producers elsewhere, producer surplus drops together with production and prices.
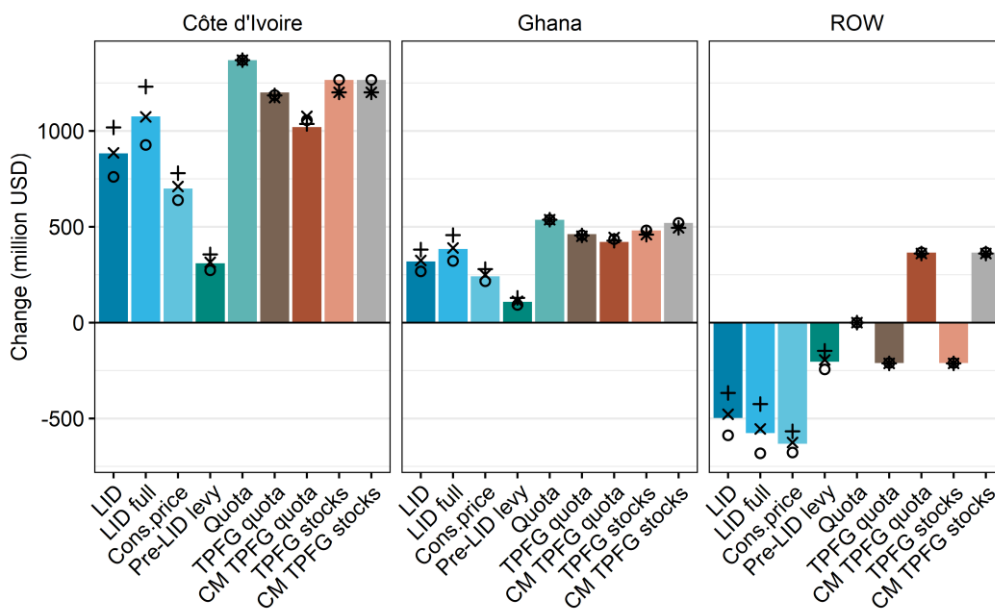

Figure 4. Change in producer surplus from pre-LID levels. ○, +, and × indicate results from alternative elasticity parameter sets A, B, and C, respectively.

15

In contrast to the *LID* scenario, the *LID full* scenario assumes that the LID markup is not subject to the usual FOB price levies and thus that the producer price increases more. The effects of the *LID* scenario are amplified, resulting in greater increases of the farmgate prices where in Côte d'Ivoire they remain USD 74 (4.1%) below the target while in Ghana they exceed it by USD 120 (6.6%). The two governments lose about 35% of revenue compared to their initial revenue from cocoa. Corresponding to the greater supply from the two countries, prices in ROW fall even further.

The higher costs for cocoa beans are passed on to final consumers of chocolate in the *cons.price* scenario, provoking a decrease in demand. This exerts downward pressure on the international price which emerges below the level of the previous two scenarios. The resulting farmgate prices, producer surpluses, and government revenues in all three regions are lower than in the *LID* scenario. For farmers elsewhere, this scenario creates the worst outcome.

The *pre-LID levy* scenario leaves the FOB price levies in the LID countries at the initial level of around 45%, providing less incentive for output expansion. The increase in farmgate prices in both countries is less than half of that in the *LID* scenario, failing to get even near the target. But the negative effects for other producing countries are also reduced strongly. This is the only scenario where the LID governments' revenues increase due to the larger volume sold and the levy from the LID markup itself.

If Côte d'Ivoire and Ghana – on top of the LID – limit their market supplies to their respective 2019 levels (*quota* scenario), farmgate prices in both (USD 1925 and 2126) exceed the target because the counteracting decrease in the international price is avoided. Correspondingly, also no negative effect for cocoa farmers elsewhere is created. However, government revenues from cocoa in both LID countries decrease to a similar extent as in the *LID* scenario due to the lower FOB price levy. Assumed that cocoa farmers are able to capture the quota rent (indicated as light-coloured slim bars in the farmgate price panel of Figure 2), the producer surplus gain here is the largest of all scenarios.

4.2   The TPFG scenario set

This scenario set investigates what it takes for the LID countries if they were strictly committed to reach the farmgate price target of USD 1820, requiring an increase of 41.1% in Côte d'Ivoire and 21.3% in Ghana, respectively. Here, two policy options are considered: a production quota (*TPFG quota*) and stocks (*TPFG stocks*) where both countries implement the same policy measured as share of 2019 supply, as explained above. Moreover, the set contrasts these two scenarios assuming "altruism" of chocolate manufacturers with the same quota and stocks scenarios but assuming a competitive market (*CM*).

Because the farmgate price in Côte d'Ivoire in 2019 is much further below the target than that in Ghana and both countries apply the policies in sync, the target is reached precisely in all four scenarios in Côte d'Ivoire while in Ghana the target is exceeded by far. The quota limit necessary in both countries is 105.9% of 2019 production under the "altruism" but 90.9% under the competitive market assumption. Accordingly, in the *TPFG quota* scenario, LID country production increases by 5.9%, causing an international market price drop and a negative effect on cocoa producers elsewhere, albeit less than in most scenarios of the previous scenario set. By contrast, in *CM TPFG quota* the production of the two countries' contracts so that the international price rises by 10.6% and cocoa production in ROW increases by 5.9%, resulting in an increase in producer surplus in ROW.

If both governments reduce supply to the market by purchasing into stocks, farmers can benefit from additional production, but it also requires substantial government resources. In the *TPFG stocks* and *CM TFPG stocks* scenarios, the governments buy up cocoa beans corresponding to about 15% and 30% of 2019 production (indicated as light-coloured slim bars in the production panel of Figure 2), respectively, depending on the assumed reaction of the chocolate manufacturers to the LID. This indeed amounts to, in the earlier case, a large part of or, in the latter, even substantially more than the production increase resulting from the farmgate price rise. The stocks require large monetary outlays, corresponding to around 37% and 75% of pre-LID 2019 cocoa government revenue in the LID countries, respectively. Because it is uncertain if and at what price the beans might be sold off at a later point, this potentially large cost item is shown separately from the government revenue effect in Figure 2. As the resulting supply to the market after the stock intervention is precisely the same as in the *TPFG quota* scenarios, the impacts on the international market and farmers elsewhere are also identical to those.

Producer surplus in Côte d'Ivoire and Ghana increases more than in the *TPFG quota* scenarios due to the larger production. Farmers in ROW gain welfare only in the CM scenarios, where the LID country producers receive the same prices as producers elsewhere so that the LID governments can raise their export price only if they reduce

market supply. Increasing their production with the rising prices, ROW farmers then benefit from price and quantity effects.

4.3 Sensitivity analysis using alternative elasticity sets

The alternative price elasticities of demand and supply are about half (56% and 50%) of those in the main elasticity set. Overall, the simulations of the different scenarios with the alternative sets yield qualitatively similar results, i.e., similar in order of magnitude and with same ordering, in regard to effects on farmgate price, producer surplus and government revenue. Nevertheless, on production the influence is large, where the effects might be about half the size of those obtained with the main elasticity set.

With supply elasticities halved (elasticity sets + and ×), production in Côte d'Ivoire and Ghana increases only half as much after introduction of the LID, leading to a somewhat stronger rise of the farmgate price and producer surplus than with the main elasticity set. Correspondingly, the international price for cocoa decreases less, thereby reducing the negative effect on the international price and thus on non-LID country producers.

If only the demand elasticity is halved (set ○), then international prices need to drop more to create the demand for absorbing the additional output compared to the main elasticity set. This implies larger decreases in farmgate prices and producer surplus in the non-LID countries.

Under quota and stocks scenarios, all elasticity sets lead to identical international prices.

5 Discussion

Based on a global multi-regional PE model of the cocoa market, this study presents a quantitative long-run analysis of the introduction of the LID for cocoa in Côte d'Ivoire and Ghana and its impacts on the domestic and global cocoa markets and cocoa farmers within these countries and elsewhere. To the best of our knowledge, this is the first study which attempts a quantitative *ex-ante* impact assessment of the LID policy. Although being at the root of a highly valuable supply chain, cocoa farmers are predominantly poor. This creates a situation where farmers out of necessity resort to child labour and expand cocoa plantations into protected forest areas to make ends meet. So far, all programs which included an intent to increase household incomes initiated by various actors have failed to substantially improve the situation. The LID policy introduced by the two countries in 2019 is a new attempt to mitigate the harsh income situation of cocoa farmers and to increase the sustainability of the sector.

As to date many details surrounding the policy itself and how market participants might react to it remain unknown, the effects of the LID are analysed by simulating a series of scenarios which vary these unknowns to investigate the extent to which the goals of the policy are reached in different settings employing the global cocoa PE model. It should be emphasized that the model simulations are a vehicle to structure the thinking around the impacts of the LID but do not represent predictions of future market outcomes.

The first set of scenarios investigates to what extent the LID policy reaches the goals of raising farmgate prices and incomes and how government revenue is affected. Analysed are the impacts of the actual LID markup of USD 400 itself while varying whether: the usual FOB price levies by the governments (cocoa boards) are reduced to 30%, the levies apply to the markup, chocolate manufacturers pass the higher production cost on to final consumers, and governments apply supply control measures. All these scenarios assume that chocolate manufacturers are fully committed to paying the LID and not letting sourcing decisions be influenced by it.

At the 2019 price level, which is only slightly lower than the level over the first five months of 2021, Côte d'Ivoire and Ghana would need an increase in the farmgate price of about 40% and 20%, respectively, to reach the target. The LID causes farmgate prices to rise between 9% and 49%, depending on the assumptions. However, while in Ghana the LID is sufficient to reach the target price in several scenarios, in Côte d'Ivoire, this level is only reached if a complementary supply control measure is introduced. Government revenues from cocoa drop markedly by between 14% and 36% in terms of 2019 cocoa revenue whenever the FOB price levies are reduced to 30%. Indeed, the scenario not reducing these levies results in only a minor share of the increase in farmgate prices of the other scenarios. Hence, the cut in the FOB price levy as defined in the LID agreement (FCC, 2019) is a crucial element for the positive effects of the LID policy on farmer welfare. Moreover, only if production is controlled to remain at the pre-LID level, farmgate prices reach and even well exceed the target level in both countries. This result is conditional on that the quota rent accrues to the farmers. The magnitude of revenue losses associated with this scenario of around 22% of pre-LID revenue combined with the importance of cocoa-related revenue for the governments, might hint at a potential conflict of interest between governments and cocoa farmers. That loss might be reduced by a reduction of the cocoa boards' provision of services, such as free or subsidized seedlings or fertilizers, which is seen as inefficient and not reaching all farmers by some (Bymolt, Laven and Tyszler, 2018) but then, in turn, might increase the input costs for farmers.

The welfare gains for farmers in the LID countries are partially at the expense of welfare of cocoa farmers in other countries which accounting for 38% of global cocoa output. For them, the LID means a drop in farmgate prices of up to 20%, inducing a decrease in output. These negative effects are avoided if the LID countries restrict market supply to the initial output level.

The second set of scenarios explores the size of interventions necessary by Côte d'Ivoire and Ghana to reach their target farmgate prices and the associated effects. Specifically, it considers two types of supply management interventions, production quotas and stocks, required to reach the LID target farmgate prices starting from the 2019 level and varying the assumption whether chocolate manufacturers are altruistically paying the LID or not. While the prices in Côte d'Ivoire meet the target, in Ghana this target is well exceeded because of the far smaller initial gap to the target price. The quota scenarios are somewhat less beneficial for farmers in terms of producer welfare than the stocks ones. With altruistic manufacturers, the quota could be even set to allow an expansion of production by 6% compared to 2019. The gain of the farmers in the quota scenarios is conditional on the quota rent accruing to the farmers. The magnitude of the quota rents shown highlights that, if the quota rent is captured by some other party, the farmers' gain could be drastically diminished or even turn into a loss. The *CM TPFG quota* scenario sticks out as an option to reach the target farmgate price and raise farmer welfare sizably while not relying on chocolate manufacturer behaviour and even creating benefits to cocoa farmers elsewhere.

The stocks scenarios illustrate the extremely high level of potential government cost for intervening with bean purchases. The actual cost is highly uncertain because it varies depending not only on if and at what price the beans can be sold off later, at which point this also would depress the international price, but also on availability of appropriate storage facilities and storage costs. Note that, because this is a long-run analysis, this stock purchase represents the average annual purchase and thus indicates a permanent surplus at the target price, given the 2019 market conditions including the low international price.

As pointed out by the failure of the ICCA buffer stocks in the 1980s described earlier, stocks are only suited for temporary price stabilisation around the (unknown) long-run market equilibrium price. The experience of the European Union with providing sectoral support and maintaining domestic prices above international prices using stocks, production quotas, and coupled and decoupled direct payments has shown that it is possible but also very costly, and it might create claims for vested interests and major inefficiencies in the economy, see Tangermann and Cramon-Taubadel (2013) for an overview. Most remembered is the situation of the European Union in the 1980s, when agricultural surpluses were bought up to maintain prices above world market levels and overflowing storages were cleared with great losses.

Moreover, stock levels get priced into the international beans price: The stocks-to-grinding ratio and the international cocoa price are strongly negatively related (Irfan-ul-Haque, 2004; Bymolt, Laven and Tyszler, 2018), so that an increase in stock levels is associated with a lower price.

Lastly, the analyses assumed that Côte d'Ivoire and Ghana implement all policies in a synchronized manner, especially in regard to supply management. This is necessary to avoid free riding. But a cartel will be prone to the typical problems of incentives to increase the individual piece of the economic pie and thus the risk to break up.

Two auxiliary simulations of the *LID* scenario (not presented), one with manufacturers paying the LID altruistically and one where they behave purely competitively, suggest that demand would need to increase by 9.8% and 20.3% compared to 2019 (everything else equal), respectively, to sustain a long-run international equilibrium price that corresponds to the farmgate target price of USD 1820. Growth in global supply and demand over the past 30 years averaged 2.5% annually while the long-run international real cocoa price moved roughly in line with the general Food Price Index (Figure 1) on a low upward trend. This is an indication that cocoa supply and demand grew roughly in balance and that limiting supply growth is important to avoid that it outstrips demand growth and depresses the price.

For cocoa farmers in other countries, the policies in this second scenario set have smaller negative effects than the actual LID policies and even quite positive impacts if chocolate manufacturers behave competitively.

The effect of the LID also depends on the chocolate manufacturers' response. It is hardly conceivable that manufacturers would pay a LID markup in the long run if they do not get marketable benefits in return. Given increasing sensitivity of consumers regarding human rights and sustainability issues in the chocolate supply chain, these could come in forms such as child labour-free, deforestation-free, or living income-paid guarantees or in improved institutional infrastructure and regulation which supports the companies' efforts towards traceability and monitoring of such issues to reduce the costs of their own programs. While higher farm incomes by themselves might decrease the necessity for child labour and clearing of protected forest areas, the magnitude of production increases caused by the LID in Côte d'Ivoire and Ghana, as suggested by the simulation results, might indicate a risk of more children labour and additional deforestation if production expansion is not controlled. The simulations showed this risk to be even higher if the target farmgate price is being forced using stock interventions. Effective prevention of additional deforestation might achieve an important part of holding production expansion in check.

Sensitivity analysis showed the results to be robust also under alternative price elasticity assumptions in terms of cocoa price and producer welfare impacts, but cocoa output effects might be substantially smaller.

Furthermore, market forces might drive manufacturers to gradually shift to other, cheaper producing countries, maybe only partially for expansion of their bulk chocolate production. Recent press reports (Almeida, Mieu and Bassompierre, 2020) about unusually large purchases of cocoa beans from the commodities futures exchange allegedly linked to chocolate manufacturers trying to avoid the LID give indications in that direction. In the long run, it also seems impossible to credibly distinguish LID markup-induced changes in sourcing decisions of the manufacturers from other business decision-based changes, rendering the monitoring of LID commitment impossible. Accordingly, the effect of the LID could diminish over time. At the time of writing, both LID countries have sold beans with a reduced or even negative country quality premium (differential) which is usually paid on top of the international price, thereby (partially) cancelling out the LID (Reuters, 2021a). However, the

difficulties to sell their harvests at the set prices including the LID also need to be seen in context with globally weak demand and strong supply do to the COVID-19 pandemic and new record harvests (Reuters, 2021b).

Regardless of whether the chocolate manufacturers continue paying the LID markup in the future or behave competitively, the simulation results show that supply management is key to attain a substantial rise in farmgate prices and producer welfare in Côte d'Ivoire and Ghana as well as to limit negative impacts on welfare of cocoa farmers elsewhere. How supply control can be implemented in an efficient and sustainable manner remains an open question. With a market share of over 60%, the two countries have the market power to influence international prices by adjusting their supply to the market. Nevertheless, although their cooperation has sometimes been nicknamed COPEC, in reference to the Organization of the Petroleum Exporting Countries (OPEC), cocoa is a very different product than crude oil. Most importantly, cocoa output cannot easily be adjusted, is the outcome of millions of individual farmers' decisions, and being perishable, it requires good storage facilities to keep the beans for a limited time without deteriorating (Beckett, Fowler and Ziegler, 2017). Correspondingly, holding cocoa in stocks has limits and can turn out to be very costly.

In any case, the LID policy represents a step towards a living income for cocoa farmers but even if the LID's target price of USD 1820 per tonne is reached, it still is a long way to a real living income. Reference farmgate prices corresponding to a living income have been calculated, for example, by Fairtrade (Veldhuyzen, 2019) to equal USD 2200 and USD 2100 per tonne for Côte d'Ivoire and Ghana, respectively, and by Fountain and Hütz-Adams (2019) to equal USD 3166 per tonne for both. These would imply another increase of between 15% and 74% on top of the LID target price.

6 Conclusions

In summary, the results presented indicate the LID policy's effects to range from none to substantially positive for prices and welfare of cocoa farmers in Côte d'Ivoire and Ghana and turn out especially positive if flanking supply control measures are effectively implemented. Government revenues from cocoa mostly get substantially negatively affected. The magnitude of the effects varies strongly depending on a variety of factors linked to policy implementation details and market participants' behaviour. These factors also determine if and how strongly welfare of cocoa farmers in other countries is harmed or even promoted.

Over the course of the study, a number of potential threats to the sustainability of the LID policy, varying with the policy's details, have been identified, which might need to be managed actively: First, as shown, the LID could incentivize a large expansion of cocoa production, implying a risk for additional child labour and deforestation. This risk could be mitigated by adopting supply management measures, such as, a limit of cocoa growing to designated areas and production quotas. Second, the reduction of the FOB price levy to 30% constitutes a correction of a market bias but also a transfer of resources from governments to farmers which creates a conflict of interests and could induce governments to revert this measure. However, such tendencies could be disciplined by a commitment to transparency of the cocoa-related budget and the price setting process. Third, the commercial interests of chocolate manufacturers might lead to a leakage of sourcing towards non-LID countries over time. This points at creating a level playing field by involving other producer countries or valuable returns for producers, e.g., in form of improved institutions and infrastructure, which reduce the costs of the chocolate manufacturers to comply with sustainability demands. Fourth, negative welfare effects on farmers in non-LID countries could result in potential disputes with those countries but could be avoided by effective supply management. Fifth, the synchronization of the LID-related policies between the two countries has been identified as a necessity to prevent free-riding and the break-up of the LID due to typical cartel problems. Thus, close coordination of all cocoa-related policies and a transparent monitoring mechanism are necessary to discipline deviations. The joint body *The Ivory Coast-Ghana Cocoa Initiative*, founded by Côte d'Ivoire and Ghana in 2020, could serve this purpose. Finally, if supply controls are introduced, it is vital to ensure that the arising rents accrue to the farmers by appropriate administration as otherwise they might even lose from the LID.

Particularly one policy option stands out: Without the need to rely on chocolate manufacturers' behaviour, if Côte d'Ivoire and Ghana were able to control supply and reduce their production, they could leverage their collective market power to the benefit of their own cocoa farmers but also of cocoa farmers elsewhere. Thus, this suggests cartel-type price making by adjusting market supply. However, whether the benefit for the farmers ultimately materializes crucially hinges on that the rents accrue to the farmers, e.g., through appropriate administration of production quota licenses.

If clearing of protected forest areas for cocoa growing is prevented effectively in the future, increases in cocoa prices will capitalise in the price of land as the limiting factor. This points out the need for formal land property rights but also that the cocoa sector cannot be considered in isolation from the rest of the agricultural sector. Indeed, Bymolt, Laven and Tyszler (2018) find that in Côte d'Ivoire and Ghana poverty is not a problem specific to cocoa but more general to rural smallholder farmers and that, despite the low incomes, cocoa growing is perceived as the "best option" among smallholder farmers.

It should be noted that this study assesses the impacts on the cocoa sector in isolation by taking a partial equilibrium perspective. However, as cocoa is a sector of major importance for agriculture in terms of value added and employment in both countries, the LID might have substantial impacts also on non-cocoa farmers. Moreover, their cocoa sectors are important sources for foreign exchange and government revenue. Following up, future research should address the impacts of the LID on the wider agricultural sector and economies of Côte d'Ivoire and Ghana. Moreover, the LID initiative and current attention for the cocoa sector could be seen as an opportunity to design a lighthouse policy which exemplifies how sustainability for the entire agricultural sector might be improved.

References

Aboa, A. (2020) 'Ivory Coast struggles to sell cocoa amid dispute over farmer premium', *Reuters*, December 1, 2020. Available at: https://www.reuters.com/article/idUSL8N2IH2HJ.

Aboa, A. and Angel, M. (2019a) 'Chocolate makers hobble Ivory Coast, Ghana cocoa premium with discounts', *Reuters*, December 17, 2019. Available at: https://www.reuters.com/article/idUSKBN1YL1W7.

Aboa, A. and Angel, M. (2019b) 'Ivory Coast, Ghana add 'living income' cocoa premium to fight poverty', *Reuters*, July 10, 2019. Available at: https://www.reuters.com/article/westafrica-cocoa-idUSL8N24B55M.

Aidenvironment (2018) *Pricing mechanisms in the cocoa sector: Options to reduce price volatility and promote farmer value capture*. Amsterdam: Aidenvironment and Sustainable Food Lab. Available at: https://www.aidenvironment.org/wp-content/uploads/2018/06/Pricing-mechanisms-in-the-cocoa-sector.Oct2018.pdf.

Almeida, I., Mieu, B. and Bassompierre, L. de (2020) 'In a global chocolate war, it's Hershey against West Africa', *Bloomberg*, November 30, 2020. Available at: https://www.bloomberg.com/news/articles/2020-11-30/top-cocoa-growers-hit-back-at-hershey-with-ethical-programs-ban.

Amanor, K. S., Yaro, J. A. and Teye, J. K. (2020) *Long-term change and agricultural commercialisation in Ghanaian cocoa*. Working Paper 31. Brighton, UK: Future Agricultures Consortium.

Barrientos, S. (2016) 'Beyond fair trade: Why are mainstream chocolate companies pursuing social and economic sustainability in cocoa sourcing', in Squicciarini, M. P. and Swinnen, J. (eds) *The economics of chocolate*. Oxford, UK: Oxford University Press, pp. 213–227.

Beckett, S. T., Fowler, M. S. and Ziegler, G. R. (eds) (2017) *Beckett's industrial chocolate manufacture and use*. 5th edn. Chichester, UK: Wiley Blackwell.

Binam, J. N., Gockowski, J. and Nkamleu, G. B. (2008) 'Technical efficiency and productivity potential of cocoa farmers in West African countries', *The Developing Economies*, 46(3), pp. 242–263. doi: 10.1111/j.1746-1049.2008.00065.x.

Bonjean, C. A. and Brun, J.-F. (2016) 'Concentration and price transmission in the cocoa–chocolate chain', in Squicciarini, M. P. and Swinnen, J. (eds) *The economics of chocolate*. Oxford, UK: Oxford University Press, pp. 339–362.

Burger, K. (2008) *Optimal export taxes? The case of cocoa in Côte d'Ivoire*. 107th EAAE Seminar, January 30-February 1, Sevilla, Spain. European Association of Agricultural Economists (EAAE). doi: 10.22004/ag.econ.6395.

Bymolt, R., Laven, A. and Tyszler, M. (2018) *Demystifying the cocoa sector in Ghana and Côte d'Ivoire*. Amsterdam: The Royal Tropical Institute (KIT).

EC (2020) *EU multi-stakeholder dialogue for sustainable cocoa, launch event: 22nd September 2020*. Summary report. Brussels: European Commission. Available at: https://ec.europa.eu/international-partnerships/system/files/launch_event_cocoa_short_report_final.pdf.

FAO and BASIC (2020) *Comparative study on the distribution of value in European chocolate chains*. Research Report – Advance Copy. Rome; Paris: Food; Agriculture Organization of the United Nations (FAO); Bureau d'Analyse Societale pour une Information Citoyenne (BASIC). Available at: https://lebasic.com/wp-content/uploads/2020/07/BASIC-DEVCO-FAO_Cocoa-Value-Chain-Research-report_Advance-Copy_June-2020.pdf.

FCC (2019) 'Implementation of Living Income Differential by Côte d'Ivoire and Ghana'. Federation of Cocoa Commerce. London, UK. Available at: http://prod-upp-image-read.ft.com/c2157a14-a964-11e9-984c-fac8325aaa04.

Fold, N. and Neilson, J. (2016) 'Sustaining supplies in smallholder-dominated value chains', in Squicciarini, M. P. and Swinnen, J. (eds) *The economics of chocolate*. Oxford, UK: Oxford University Press, pp. 195–212.

Fountain, A. C. and Hütz-Adams, F. (2015) *Cocoa barometer 2015*. Ede, Netherlands: VOICE Network. Available at: https://www.voicenetwork.eu/wp-content/uploads/2019/07/Cocoa-Barometer-2015-Print-Friendly-Version.pdf.

Fountain, A. C. and Hütz-Adams, F. (2018) *Cocoa barometer 2018*. Ede, Netherlands: VOICE Network. Available at: https://www.voicenetwork.eu/wp-content/uploads/2019/08/Cocoabarometer2018_web4.pdf.

Fountain, A. C. and Hütz-Adams, F. (2019) *Necessary farm gate prices for a living income*. Consultation Paper for the 2020 Cocoa Barometer. Ede, Netherlands: VOICE Network. Available at: https://www.voicenetwork.eu/wp-content/uploads/2020/01/200113-Necessary-Farm-Gate-Prices-for-a-Living-Income-Definitive.pdf.

Fountain, A. C. and Hütz-Adams, F. (2020) *Cocoa barometer 2020*. Ede, Netherlands: VOICE Network. Available at: https://www.voicenetwork.eu/wp-content/uploads/2020/12/2020-Cocoa-Barometer.pdf.

Gayi, S. K. and Tsowou, K. (2016) *Cocoa industry: Integrating small farmers into the global value chain*. Report UNCTAD/SUC/2015/4. Geneva, Switzerland: United Nations Conference on Trade; Development (UNCTAD).

Gibson, J. (2007) *Consistently inconsistent: Addressing income volatility among cocoa producers in Ghana and Côte d'Ivoire*. Winnipeg, Canada: International Institute for Sustainable Development (IISD), pp. 1–48.

Gilbert, C. L. (1996) 'International Commodity Agreements: An obituary notice', *World Development*, 24(1), pp. 1–19. doi: 10.1016/0305-750X(95)00121-R.

Gilbert, C. L. (2008) 'Value chain analysis and market power in commodity processing with application to the cocoa and coffee sectors', in Hallam, D. and Rapsomanikis, G. (eds) *Commodity market review 2007-2008*. Rome: Food; Agriculture Organization of the United Nations (FAO), pp. 5–34.

Gilbert, C. L. (2012) *The dynamics of the world cocoa price*. Prepared for the 1st Conference on the Economics and Politics of Chocolate, 16-18 September 2012. Belgium: University of Leuven.

Gilbert, C. L. (2014) *Stockholding, investment and commodity price dynamics: The world cocoa market*. Prepared for the 8th International Conference on Computational and Financial Econometrics, December 2014. Pisa, Italy.

Gilbert, C. L. (2016) 'The dynamics of the world cocoa price', in Squicciarini, M. P. and Swinnen, J. (eds) *The economics of chocolate*. Oxford, UK: Oxford University Press. doi:10.1093/acprof:oso/9780198726449.003.0016.

Gilbert, C. and Varangis, P. (2004) 'Globalization and international commodity trade with specific reference to the West African cocoa producers', in Baldwin, R. E. and Winters, L. A. (eds) *Challenges to globalization: Analyzing the economics*. Chicago, IL: University of Chicago Press, pp. 131–166.

Goldman, E. D., Weisse, M., Harris, N. and Schneider, M. (2020) *Estimating the role of seven commodities in agriculture-linked deforestation: oil palm, soy, cattle, wood fiber, cocoa, coffee, and rubber*. Technical Note. Washington, DC: World Resources Institute.

Grumiller, J., Raza, W., Staritz, C., Grohs, H., Arndt, C. and Troster, B. (2018) *Perspectives for export-oriented industrial policy strategies for selected African countries: Case studies Côte d'Ivoire, Ghana and Tunisia*. Research Report 10/2018. Vienna, Austria: Austrian Foundation for Development Research (OFSE).

Hütz-Adams, F., Huber, C., Knoke, I., Morazán, P. and Mürlebach, M. (2016) *Strengthening the competitiveness of cocoa production and improving the income of cocoa producers in West and Central Africa*. Bonn, Germany: Südwind. Available at: https://suedwind-institut.de/files/Suedwind/Publikationen/2017/2017-06_Strengthening_the_competitiveness_of_cocoa_production_and_improving_the_income_of_cocoa_producers_in_West_and_Central_Africa.pdf.

Hütz-Adams, F. and Schneeweiß, A. (2018) *Pricing in the cocoa value chain - causes and effects*. Eschborn, Germany: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

ICCO (2008) *Optimal export taxes in cocoa producing countries*. Consultative Board on the World Cocoa Economy, 15th meeting, ICCO Offices, 14 January 2008. London, UK: International Cocoa Organization.

ICCO (2020a) 'ICCO producer prices - 2006-2017'. International Cocoa Organization, Abidjan, Côte d'Ivoire. Retrieved on August 4, 2020 from https://www.icco.org/about-us/international-cocoa-agreements/doc_download/4529-producer-prices-2006-2017.html.

ICCO (2020b) *Quarterly bulletin of cocoa statistics*. Volume XLVI No. 4, Cocoa Year 2019/20. Abidjan, Côte d'Ivoire: International Cocoa Organization.

Irfan-ul-Haque (2004) *Commodities under neoliberalism: The case of cocoa*. G-24 Discussion Paper Series No. 25. New York, NY: United Nations Conference on Trade and Development (UNCTAD). Available at: https://digitallibrary.un.org/record/521291.

Kolavalli, S. and Vigneri, M. (2011) 'Cocoa in Ghana: Shaping the success of an economy', in Chuhan-Pole, P. and Angwafo, M. (eds) *Yes, Africa can: Success stories from a dynamic continent*. Washington, DC: The World Bank, pp. 201–217.

Kolavalli, S. and Vigneri, M. (2017) *The cocoa coast: The board-managed cocoa sector in Ghana*. Washington, DC: International Food Policy Research Institute (IFPRI). doi: 10.2499/9780896292680.

Kongor, J. E., De Steur, H., Van de Walle, D., Gellynck, X., Afoakwa, E. O., Boeckx, P. and Dewettinck, K. (2018) 'Constraints for future cocoa production in Ghana', *Agroforestry Systems*, 92, pp. 1373–1385. doi: 10.1007/s10457-017-0082-9.

KPMG (2013) *Improving smallholder livelihoods: Effectiveness of certification in coffee, cocoa and cotton*. Study commissioned by SUSTAINEO. Netherlands: KPMG Advisory N.V. Available at: https://www.icco.org/wp-content/uploads/2019/07/121105_Study-on-the-costs-advantages-and-disadvantages-of-cocoa-certification_FINAL_Erratum-1.pdf.

Krauss, J. E. and Barrientos, S. (2021) 'Fairtrade and beyond: Shifting dynamics in cocoa sustainability production networks', *Geoforum*, 120, pp. 186–197. doi: 10.1016/j.geoforum.2021.02.002.

Kroeger, A., Bakhtary, H., Haupt, F. and Streck, C. (2017) *Eliminating deforestation from the cocoa supply chain*. Washington, DC: World Bank.

Luckstead, J., Tsiboe, F. and Nalley, L. L. (2019) 'Estimating the economic incentives necessary for eliminating child labor in Ghanaian cocoa production', *PLOS ONE*, 14(6), p. e0217230. doi: 10.1371/journal.pone.0217230.

Maile, F. (2020) *Cooperation or confrontation? Public and private governance and smallholders' incomes in the cocoa sector in Ghana and in Côte d'Ivoire*. Master Thesis. University of Vienna, Austria. Available at: https://www.oefse.at/fileadmin/content/Downloads/Publikationen/Foren/forum74_maile_web.pdf

Meier, C., Sampson, G., Larrea, C., Schlatter, B., Voora, V., Dang, D., Bermudez, S., Wozniak, J. and Willer, H. (2020) *The state of sustainable markets 2020: Statistics and emerging trends*. Geneva: International Trade Centre (ITC).

Odijie, M. E. (2018) 'Sustainability winners and losers in business-biased cocoa sustainability programmes in West Africa', *International Journal of Agricultural Sustainability*, 16(2), pp. 214–227. doi: 10.1080/14735903.2018.1445408.

Oomes, N., Tieben, B., Laven, A., Ammerlaan, T., Appelman, R., Biesenbeek, C. and Buunk, E. (2016) *Market concentration and price formation in the global cocoa value chain*. SEO-Report 2016-79. Amsterdam, Netherlands: SEO Amsterdam Economics.

Poelmans, E. and Swinnen, J. (2016) 'A brief economic history of chocolate', in Squicciarini, M. P. and Swinnen, J. (eds) *The economics of chocolate*. Oxford, UK: Oxford University Press, pp. 11–42.

Quarmine, W., Haagsma, R., Huis, A., Sakyi-Dawson, O., Obeng-Ofori, D. and Asante, F. (2014) 'Did the price-related reforms in Ghana's cocoa sector favour farmers?', *International Journal of Agricultural Sustainability*, 12(3), pp. 248–262. doi: 10.1080/14735903.2014.909639.

Reuters (2021a) 'Ivory Coast, Ghana push cocoa industry to boost premium payments', *Reuters*, May 13, 2021. Available at: https://www.reuters.com/world/africa/ivory-coast-ghana-push-cocoa-industry-boost-premium-payments-2021-05-13/.

Reuters (2021b) 'Ivory Coast says chocolate traders failing to pay farmers living wage premium', *Reuters*, June 19, 2021. Available at: https://www.reuters.com/world/africa/ivory-coast-says-chocolate-traders-failing-pay-farmers-living-wage-premium-2021-06-18/.

Sadhu, S., Kysia, K., Onyango, L., Zinnes, C., Lord, S., Monnard, A. and Arellano, I. R. (2020) *Assessing progress in reducing child labor in cocoa production in cocoa growing areas of Côte d'Ivoire and Ghana*. NORC Final Report. Chicago, IL: NORC at the University of Chicago.

Stoop, P., Ramanan, N., Geens, H., Lambrecht, A. and Dekeister, S. (2021) *Technical brief on cocoa traceability in West and Central Africa*. IDH, GISCO and C-lever.org. Available at: https://www.idhsustainabletrade.com/uploaded/2021/04/Cocoa-Traceability-Study-20.7L.pdf.

Tangermann, S. and Cramon-Taubadel, S. von (2013) *Agricultural policy in the European Union: An overview*. Diskussionsbeitrag 1302. Department of Agricultural Economics and Rural Development, University of Göttingen, Germany.

Thorlakson, T. (2018) 'A move beyond sustainability certification: The evolution of the chocolate industry's sustainable sourcing practices', *Business Strategy and the Environment*, 27(8), pp. 1653–1665. doi: 10.1002/bse.2230.

Tothmihaly, A. (2018) 'How low is the price elasticity in the global cocoa market?', *African Journal of Agricultural and Resource Economics*, 13(3), pp. 209–223. doi: 10.22004/ag.econ.284986.

Tröster, B., Staritz, C., Grumiller, J. and Maile, F. (2019) *Commodity dependence, global commodity chains, price volatility and financialisation: Price-setting and stabilisation in the cocoa sectors in Côte d'Ivoire and Ghana*. Working Paper 62. Vienna, Austria: Austrian Foundation for Development Research (ÖFSE). Available at: https://www.oefse.at/fileadmin/content/Downloads/Publikationen/Workingpaper/WP62-Cocoa-Price-setting.pdf.

UN comtrade (2021) 'UN comtrade'. United Nations (UN), NY. Available at: https://comtrade.un.org/data (Accessed: 9 April 2021).

UNCTAD (2010) *New International Cocoa Agreement concluded*. Press Release UNCTAD/PRESS/PR/2010/026, June 25, 2010. Geneva, Switzerland: United Nations Conference on Trade; Development (UNCTAD). Available at: UNCTAD/PRESS/PR/2010/026.

Veldhuyzen, C. (2019) *Fairtrade living income reference prices for cocoa*. An explanatory note (revised version 2019). Bonn, Germany: Fairtrade. Available at: https://files.fairtrade.net/2019_RevisedExplanatoryNote_FairtradeLivingIncomeReferencePriceCocoa.pdf.

Vigneri, M. and Kolavalli, S. (2018) *Growth through pricing policy: The case of cocoa in Ghana*. Background paper to the UNCTAD-FAO Commodities and Development Report 2017: Commodity markets, economic growth and development. Rome, Italy: Food and Agriculture Organization of the United Nations (FAO).

Voora, V., Bermúdez, S. and Larrea, C. (2019) *Global market report: cocoa*. Sustainable Commodities Marketplace Series. Winnipeg, Canada: International Institute for Sustainable Development (IISD).

WCF (2012) *Cocoa market update*. March 2012. Washington, DC: World Cocoa Foundation. Available at: http://worldcocoafoundation.org/wp-content/uploads/Cocoa-Market-Update-as-of-3.20.2012.pdf

World Bank (2019) *Situation economique en Côte d'Ivoire: Au pays du cacao - comment transformer la Côte d'Ivoire*. Report. Washington, DC: World Bank.

World Bank (2021) 'Pink Sheet Data'. Annual indices (real), May 2021. World Bank, Washington, DC. Retrieved on May 24, 2021 from https://www.worldbank.org/en/research/commodity-markets.

WRI (2021) 'Global forest review, deforestation linked to agriculture'. World Resources Institute, Washington, DC. Retrieved on April 14, 2021 from https://research.wri.org/gfr/forest-extent-indicators/deforestation-agriculture.

WTO (2014) *Trade policy review: Ghana – revision*. Report by the Secretariat WT/TPR/S/298/Rev.1. Geneva, Switzerland: World Trade Organization, p. 104. doi: 10.30875/df26c4bc-en.

WTO (2017) *Trade policy review: The member countries of the West African Economic and Monetary Union (WAEMU)*. Report by the Secretariat WT/TPR/S/362. Geneva, Switzerland: World Trade Organization, p. 527. doi: 10.30875/128692c9-en.

List of abbreviations and definitions

CCC	Conseil du Café-Cacao
CIF	Cost-Insurance-Freight
COCOBOD	Ghana Cocoa Marketing Board
FOB	Free on Board
FPI	Food Price Index
ICCO	International Cocoa Organisation
ICCA	International Cocoa Agreement
LID	Living Income Differential
MUV	Manufactures Unit Value
OPEC	Organization of the Petroleum Exporting Countries
PE	Partial Equilibrium
ROW	Rest of the World
USD	United States Dollar

List of figures

List of tables

The European Commission's science and knowledge service

Joint Research Centre

JRC Mission

As the science and knowledge service of the European Commission, the Joint Research Centre's mission is to support EU policies with independent evidence throughout the whole policy cycle.

EU Science Hub
ec.europa.eu/jrc

@EU_ScienceHub

EU Science Hub - Joint Research Centre

EU Science, Research and Innovation

EU Science Hub

Publications Office
of the European Union